NIST TIME AND FREQUENCY BULLETIN
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1. GENERAL BACKGROUND INFORMATION

ACRONYMS AND ABBREVIATIONS USED IN THIS BULLETIN

BIPM - Bureau International des Poids et Mesures
Cs - Cesium standard
GPS - Global Positioning System
IERS - International Earth Rotation Service
LORAN - Long Range Navigation
MC - Master Clock
MJD - Modified Julian Date
NVLAP - National Voluntary Laboratory Accreditation Program
NIST - National Institute of Standards and Technology
NOAA - National Oceanic and Atmospheric Administration
SI - International System of Units
TA - Atomic Time
TAI - International Atomic Time
USNO - United States Naval Observatory
UTC - Coordinated Universal Time

ns - nanosecond
µs - microsecond
ms - millisecond
s - second
min - minute

2. TIME-SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from all available common-view GPS satellites (see bibliography on page 5). **UTC - UTC(NIST) data are on page 3.**

0000 HOURS COORDINATED UNIVERSAL TIME			
JULY 2003	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
3	52823	-366 ms	5 ns
10	52830	-364 ms	5 ns
17	52837	-358 ms	6 ns
24	52844	-356 ms	5 ns
31	52851	-353 ms	3 ns

NOTE: The values for UTC(USNO,MC)-UTC(NIST) had incorrect positive/negative signs for MJD's 52585-52816 (inclusive). We regret any inconvenience this may have caused.

The master clock pulses used by the WWV, WWVH, and WWVB time-code transmissions are referenced to the UTC(NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the rate of rotation of the Earth.

NOTE: NO leap second will be inserted at the end of December 2003.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC timescale on 30 June 1972, 1981-1983, 1985, 1992, 1993, 1994, and 1997, and on 31 December 1972-1979, 1987, 1989, 1990,1995, and 1998. There have been 22 leap seconds inserted in total.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, and WWVB and are printed below. These corrections may be added to received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =	+0.1 s beginning 0000 UTC 19 October 2000 +0.0 s beginning 0000 UTC 01 March 2001 -0.1 s beginning 0000 UTC 04 October 2001 -0.2 s beginning 0000 UTC 14 February 2002 -0.3 s beginning 0000 UTC 24 October 2002 -0.4 s beginning 0000 UTC 03 April 2003

The deviation of UTC(NIST) from UTC has been within +/–100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their Circular T publication for the most recent 310-day period in which data are available. Data are given at ten day intervals. Five day interval data are available in Circular T.

0000 Hours Coordinated Universal Time

DATE	MJD	UTC-UTC(NIST) ns
Jun. 29, 2003	52819	9.2
Jun. 19, 2003	52809	7.5
Jun. 9, 2003	52799	3.8
May 30, 2003	52789	0.6
May 20, 2003	52779	4.0
May 10, 2003	52769	10.4
Apr. 30, 2003	52759	8.9
Apr. 20, 2003	52749	10.7
Apr. 10, 2003	52739	10.9
Mar. 31, 2003	52729	11
Mar. 21, 2003	52719	12
Mar. 11, 2003	52709	11
Mar. 1, 2003	52699	7
Feb. 19, 2003	52689	8
Feb. 9, 2003	52679	7
Jan. 30, 2003	52669	2
Jan. 20, 2003	52659	-1
Jan. 10, 2003	52649	-5
Dec. 31, 2002	52639	-2
Dec. 21, 2002	52629	-3
Dec. 11, 2002	52619	-4
Dec. 1, 2002	52609	-3
Nov. 22, 2002	52599	2
Nov. 12, 2002	52589	3
Nov. 2, 2002	52579	4
Oct. 22, 2002	52569	5
Oct. 12, 2002	52559	4
Oct. 2, 2002	52549	4
Sept. 22, 2002	52539	3
Sept. 12, 2002	52529	0
Sept. 2, 2002	52519	-1

3. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time differences between the time markers of the UTC(NIST) time scale and the first positive-going zero voltage crossover measured at the transmitting antenna. The uncertainty of the individual measurements is ±0.5 μs. The values listed are for 1300 UTC.

LORAN-C - The values shown for Loran-C represent the daily accumulated phase shift (in ns). The phase shift is measured by comparing the output of a Loran receiver to the UTC(NIST) time scale for a period of 24 h. If data were not recorded on a particular day, the symbol (-) is printed. The stations monitored are Baudette, ND (8970-Y) and Fallon, NV (9940). The monitoring is done from the NIST laboratories in Boulder, Colorado.

Note: The values shown for Loran-C are in nanoseconds.

		UTC(NIST)-WWVB (60 kHz)	UTC(NIST) - LORAN PHASE (ns)	
DATE	MJD	ANTENNA PHASE (μs)	LORAN-C (BAUDETTE) (8970)	LORAN-C (FALLON) (9940)
07/01/03	52821	5.62	-76	-118
07/02/03	52822	5.62	+41	+185
07/03/03	52823	5.74	-27	+158
07/04/03	52824	5.73	+21	-300
07/05/03	52825	5.72	+8	-142
07/06/03	52826	5.72	-78	+202
07/07/03	52827	5.72	-158	+258
07/08/03	52828	5.72	+33	+219
07/09/03	52829	5.78	+9	-165
07/10/03	52830	5.79	-215	+306
07/11/03	82831	5.76	+190	-170
07/07/03	52832	5.75	+47	-283
07/13/03	52833	5.75	-18	-105
07/14/03	52834	5.75	-10	-145
07/15/03	52835	5.76	-8	+306
07/16/03	52836	5.77	-45	+39
07/17/03	52837	5.76	+47	-193
07/18/03	52838	5.76	+16	-151
07/19/03	52839	5.75	-180	+22
07/20/03	52840	5.75	-2	+193
07/21/03	52841	5.74	+19	+76
07/22/03	52842	5.72	+250	-36
07/23/03	52843	5.74	-64	-97
07/24/03	52844	5.74	+49	+5
07/25/03	52845	5.72	+226	-84
07/26/03	52846	5.72	-9	-172
07/27/03	52847	5.72	+96	-375
07/28/03	52848	5.72	-150	-463
07/29/03	52849	5.73	+98	+146
07/30/03	52850	5.73	+15	+98
07/31/03	52851	5.72	-221	+415

4. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

WWVB 60 kHz OUTAGES OF 5 MINUTES OR MORE							PHASE PERTURBATIONS 2 ms			
Station	AUG 2003	MJD	Began UTC	Ended UTC	Freq.		AUG 2003	MJD	Began UTC	End UTC
WWVB	07-24-03	52844	0522	0546	60 kHz					
WWVB	07-06-03	52826	0730	0808	60 kHz					
WWVB	07-04-03	52824	1025	1100	60 kHz					
WWV										
WWVH										

5. NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS

Primary frequency standards developed and maintained by NIST are used to provide accuracy (rate) input to the BIPM. NIST-7, which had served as the U.S. primary standard since 1994, has been replaced by NIST-F1, a cesium fountain frequency standard. The uncertainty of the new standard is currently 1.7 parts in 10^{15}.

The AT1 scale is run in real-time using data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as nearly constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC using data published by the BIPM in its Circular T. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and very occasionally at mid-month. A change in frequency is limited to no more than ± 2 ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

UTC is generated at the BIPM using a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent data available.

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Table 7.1 lists parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Day, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offset in time and in frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC as specified by the IERS. Leap seconds are not applied to AT1.

Table 7.1
UTC(NIST) - AT1 = x_{ls} + x + y*(T –T_0)

Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Aug 03	-32	-252702.95	-39.5*	52852	52883*
Jul 03	-32	-252228.95	-39.5	52840	52852
Jul 03	-32	-251473.7	-39.75	52821	52840†
Jun 03	-32	-251076.2	-39.75	52811	52821
Jun 03	-32	-250276.2	-40.0	52791	52811†
May 03	-32	-249652.2	-39.0	52775	52791
May 03	-32	-249052.2	-40.0	52760	52775†
Apr 03	-32	-248495.7	-39.75	52746	52760
Apr 03	-32	-247855.7	-40.0	52730	52746†
Mar 03	-32	-247415.7	-40.0	52719	52730
Mar 03	-32	-246607.7	-40.4	52699	52719†
Feb 03	-32	-246284.9	-40.35	52691	52699
Feb 03	-32	-245474.9	-40.5	52671	52691†
Jan 03	-32	-244906.5	-40.6	52657	52671
Jan 03	-32	-244218.0	-40.5	52640	52657†
Dec 02	-32	-243813.0	-40.5	52630	52640
Dec 02	-32	-242964.6	-40.4	52609	52630†
Nov 02	-32	-242399.0	-40.4	52595	52609
Nov 02	-32	-241751.0	-40.5	52579	52595†
Oct 02	-32	-240495.5	-40.5	52548	52579
Sep 02	-32	-240252.5	-40.5	52542	52548
Sep 02	-32	-239274.5	-40.75	52518	52542†
Aug 02	-32	-238577.5	-41.0	52501	52518
Aug 02	-32	-238014.25	-40.25	52487	52501†
Jul 02	-32	-236766.5	-40.25	52456	52487

† Rate change in mid-month
†† Rate change one day early
***Provisional value**

7. SPECIAL ANNOUNCEMENTS

NOTICE TO DISCONTINUE INVOLVEMENT WITH GOES TIME CODE SERVICE

NIST has announced that it will discontinue its involvement with the time code broadcast from the GOES WEST and GOES EAST satellites operated by the National Oceanic and Atmosphere Administration (NOAA) on January 1, 2005. This decision has been jointly made by NIST and NOAA in response to the fact that nearly all users requiring time more accurate than 1 millisecond now use the Global Positioning System (GPS), and as a result, commercial sources for GOES timing receivers no longer exist.

NOAA is expected to continue to provide a GOES time code indefinitely after January 1, 2005, and existing receivers should be able to continue to receive and decode the time signal. However, the time code will no longer be controlled and checked by NIST, and the received time is expected to be less accurate when NIST discontinues its involvement. The GOES satellites currently broadcast continuously updated position information in addition to the time, so that GOES receivers can automatically correct for path delay changes caused by satellite motion. This allows the current system to have a time uncertainty of less than 100 microseconds. NOAA is expected to continuously broadcast a fixed position from the satellites, which could increase the time uncertainty to 1 millisecond or more.

The GOES time broadcasts began in 1974 and have served many applications and thousands of users. NIST will continue to control and monitor the time code through January 1, 2005 to allow users who require a high accuracy signal sufficient time to replace their existing receivers. If you have additional questions, please contact Michael Lombardi, 303-497-3212, or email lombardi@boulder.nist.gov.

IMPORTANT NOTICE!

Effective January 1, 2004, NIST will discontinue sending the bulletin by mail.

The Time and Frequency Bulletin data are now online at

www.boulder.nist.gov/timefreq/pubs/bulletin/timescaleindex.htm

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